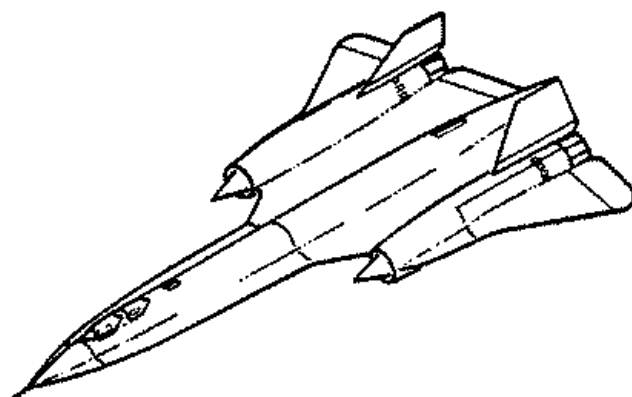


SP-71A-1

Appendix I



Performance Data

	Abbreviations and Symbols	A-2
Part I	Introduction	A1-1
Part II	Takeoff and Landing Performance	A2-1
Part III	Climb and Descent Performance	A3-1
Part IV	Subsonic Cruise Performance	A4-1
Part V	Supersonic Cruise Performance	A5-1
Part VI	Mission Planning Data	A6-1

CLASSIFIED BY: SENIOR CROWN SECURITY
DECLASSIFICATION GUIDE: 5-25-89
DECLASSIFIED BY: OADR

APPENDIX I

ABBREVIATIONS AND SYMBOLS

Abbreviations	Definitions	Abbreviations	Definitions
AA	Air to Air	FAT	Free Air Temperature
A/B	Afterburner	FDC	Flight Director Computer
ADF	Automatic Direction Finder	FP	Fix Point
ADI	Attitude Director Indicator	FRL	Fuselage Reference Line
ADS	Accessory Drive System	GSE	Ground Support Equipment
ANS	Astroinertial Navigation System	GW	Gross Weight
APW	Automatic Pitch Warning	HF	High Frequency
AR	Air Refueling	HSI	Horizontal Situation Indicator
ARCP	Air Refueling Control Point	IAF	Initial Approach Fix
ARCT	Air Refueling Control Time	ICS	Inter-Communications System
BDHI	Bearing Distance Heading Indicator	IFF	Identification Friend or Foe
BIT	Built-in Test	IGV	Inlet Guide Vanes
BO	Boom Operator	ILS	Instrument Landing System
CB	Circuit Breaker	INS	Inertial Navigation System
CCF	Chart Convergence Factor	IR	Infrared
CCW	Counterclockwise	IVSI	Inertial-Lead Vertical Speed Indicator
CDI	Course Deviation Indicator	KHz	Kilo-hertz
CEP	Circular Error Probability	KCAS	Knots Calibrated Air Speed
CG	Center of Gravity	KEAS	Knots Equivalent Air Speed
CIP	Compressor Inlet Pressure	KIAS	Knots Indicator Air Speed
CIT	Compressor Inlet Temperature	KTAS	Knots True Air Speed
COMINT	Communication Intelligence	LN2	Liquid Nitrogen
CSC	Control Stick Command	LOX	Liquid Oxygen
CP	Control Point	MAC	Mean Aerodynamic Chord
DAFICS	Digital Automatic Flight and Inlet Control System	MAG	Magnetic
DEF	Defense System	MAL	Malfunction
DP	Destination Point	MHz	Mega-hertz
DPR	Duct Pressure Ratio	MRS	Mission Recorder System
EGT	Exhaust Gas Temperature	NCD	Navigation Control Panel
ELINT	Electronic Intelligence	NDRO	Non-Destructive Readout
EMF	Electromotive Force	NM	Nautical Mile
EMR	Electromagnetic Reconnaissance	NWS	Nose Wheel Steering
ENP	Exhaust Nozzle Position	OBC	Optical Bar Camera
ETA	Estimated Time of Arrival	PP	Present Position
EWS	Electronic Warfare System	PRF	Pulse Repetition Frequency
		PVD	Peripheral Vision Display

ABBREVIATIONS AND SYMBOLS

Abbreviations	Definitions	Abbreviations	Definitions
R/C	Rate of Climb	TROC	Terrain Objective Camera
RCD	Recorder Correlator Display	T/R	Transmit - Receive
RCR	Runway Condition Reading	TSA	Turn Start Automatic
R/D	Rate of Descent	UHF	Ultra High Frequency
RSC	Runway Surface Covering	V/H	Velocity/Height
RSO	Reconnaissance Systems Operator	WRP	Wing Reference Plane
SAS	Stability Augmentation System	W/δ	Cruise Parameter
SES	Shock Expulsion Sensor	XFMR	Transformer
SLR	Side Looking Radar	ZFW	Zero Fuel Weight
TACAN	Tactical Air Navigation	α	Angle of Attack
TDI	Triple Display Indicator	$\dot{\theta}$	Pitch Rate
TEB	Triethylborane	ϕ	Bank Angle
TECH		Θ	Pitch Angle
TEOC	Technical Objective Camera		
TGS	Takeoff Ground Speed		
TOL	Takeoff and Landing		
TOLR	Tolerance		

PART I

INTRODUCTION

TABLE OF CONTENTS

	<u>Page</u>
SCOPE AND ARRANGEMENT	A1-2
PERFORMANCE DATA BASIS	A1-2
FUEL AND FUEL DENSITY	A1-2
AIRSPPEED SYSTEMS	A1-2
POSITION ERROR CORRECTIONS	A1-2
COMPRESSIBILITY CORRECTIONS	A1-2
TRUE MACH NUMBER VS EQUIVALENT AIRSPEED	A1-3
MACH - AIRSPEED - TEMPERATURE	A1-3
STANDARD ATMOSPHERE	A1-3
STANDARD UNITS CONVERSION	A1-3
W/ δ AS A FUNCTION OF GROSS WEIGHT AND ALTITUDE	A1-3
BANK ANGLE vs LOAD FACTOR	A1-3

LIST OF ILLUSTRATIONS

	<u>Figure No.</u>
Position Error Corrections:	
Vs Mach	A1-1
Vs IAS	A1-2
Airspeed Compressiblity Correction	A1-3
Difference Between IAS and EAS	A1-4
True Mach Number Vs EAS	A1-5
TDI Mach-KEAS-Altitude-Relationship Above FL 650	A1-6
Mach-Airspeed-Temperature Conversion	A1-7
Mach-Airspeed-Temperature Conversions Above Mach 2.6	A1-8
Standard Atmosphere Table (1956)	A1-9
Free Air Temperature Variation with Altitude	A1-10
Standard Units Conversion Chart	A1-11
W/ δ as a Function of Gross Weight and Altitude	A1-12
Typical Variation of Fuel Density with Temperature	A1-13

APPENDIX I
PART I

SR-71A-1

SCOPE AND ARRANGEMENT

This appendix contains performance data in chart form to aid flight planning. The material is grouped into phases of flight. Descriptive text explains the use of the charts. Profile charts are included for subsonic and supersonic cruise missions.

PERFORMANCE DATA BASIS

This performance data is based on USAF Category II and Contractor flight tests of aircraft equipped with J-58 (JT11D-20) engines rated at 34,000 pounds maximum sea level static thrust. The basic material is presented for standard atmospheric conditions as defined by the 1956 ARDC Standard Atmosphere. Corrections for nonstandard temperature have been included when possible.

FUEL AND FUEL DENSITY

Performance and operating weight are based on JP-7 (PWA-535) fuel at a fuel density of 6.57 pounds per gallon. The effect on operational capabilities must be considered if fuel density is different from this nominal value. Typical variation of JP-7 fuel density with temperature is shown in Figure A1-11. With full fuel tanks, the fuel load varies 1220 pounds for each 0.1 pound per gallon change in fuel density.

AIRSPEED SYSTEMS

Airspeed, altitude, and Mach are available from both the pitot-static instruments (airspeed indicator and altimeter) and from the triple display indicator (TDI). The pitot-static instruments provide conventional pressure altitude and indicated airspeed-Mach indications. The TDI provides digital values of equivalent airspeed (KEAS), corrected pressure altitude, and true Mach number. The difference between indicated airspeed (KIAS) and KEAS is a function of speed, altitude, and position error.

NOTE

Sections II and VII designate which of the systems should normally be used for the various phases of flight.

POSITION ERROR CORRECTIONS

Pitot-Static Instruments

Figures A1-1 and A1-2 supply position error corrections for the altimeter and airspeed indicator. Subsonic corrections were obtained from inflight and ground run calibrations. Supersonic corrections were obtained from wind tunnel calibrations.

Triple Display Indicator (TDI)

The TDI is almost completely compensated for position error and compressibility effects. However, the TDI may lag slightly during takeoff.

COMPRESSIBILITY CORRECTIONS

Standard corrections for compressibility effects on KIAS are provided by Figure A1-3. To obtain KEAS, subtract these corrections from KIAS after the position error corrections have been made.

A comparison of KEAS from the TDI and KIAS from the normal ship system is shown on Figure A1-4. This Figure is the basis for the normal climb and descent and limit indicated airspeed values provided by the placard on the TDI. For example, at 400 KEAS, the normal ship system indicates 422 KIAS at 20,000 feet indicated pressure altitude and 476 KIAS at 50,000 feet indicated pressure altitude. Other combinations of indicated altitude and KIAS can be determined from Figure A1-4 and used to determine KEAS if the TDI fails.

**TRUE MACH NUMBER VS
EQUIVALENT AIRSPEED**

Figures A1-5 and A1-6 show the relationship between true Mach number, pressure altitude, and equivalent airspeed (KEAS), based on a "gamma" of 1.4. ($\gamma = 1.4$ is the standard specific heat ratio for air below 350°C. It decreases slightly at higher temperatures.) Figure A1-6 is a rearrangement and expansion of part of the material on sheet 3 of Figure A1-5. It is applicable between FL 650 and FL 860 from Mach 2.55 to Mach 3.35. It is also reproduced in the pilot's and RSO's checklists. In flight, it can be used to check the TDI Mach-KEAS-Altitude display.

**MACH-AIRSPEED-TEMPERATURE
RELATIONSHIP**

Ambient air temperature and true airspeed can be obtained from CIT and TDI Mach as shown on the Mach-Airspeed-Temperature charts, Figures A1-7 and A1-8. For example, as shown on Figure A1-7, at a TDI Mach of 3.05 and CIT of 300°C the ambient temperature is -072°C and the true airspeed is 1686 knots. The effect of adiabatic compression and temperature rise on atmospheric characteristics has been included by using a variable γ parameter.

Figure A1-8 is a rearrangement and expansion of Figure A1-7 between Mach 2.55 and 3.35. Special emphasis is given to the CIT range above 300°C to provide increased reading accuracy for true airspeeds encountered at normal cruise speeds. This chart is also reproduced in the pilot's and RSO's checklists. In flight, it can be used with the ANS true airspeed output to cross-check the TDI and pitot-static system Mach displays at normal cruise speeds. It can also be used to check ambient temperature so

that the effects of FAT on cruise and maneuvering capability can be anticipated.

STANDARD ATMOSPHERE

The 1956 ARDC standard atmosphere table, Figure A1-9, provides reference temperature, pressure, air density, and sonic speed information which may be of assistance in flight planning. Figure A1-10 compares the 1956 ARDC standard atmosphere and the ML-STD-210A tropic atmosphere temperature vs altitude schedules.

STANDARD UNITS CONVERSION

The standard units conversion chart, Figure A1-11, provides a means for conversion of temperature, distance, and speed between English and metric units.

**W/ δ AS A FUNCTION OF
GROSS WEIGHT AND ALTITUDE**

Figure A1-12 presents the relationship between the cruise parameter W/δ and airplane gross weight and altitude.

BANK ANGLE vs LOAD FACTOR

The following table provides the load factors associated with bank angles up to 70° during coordinated level turns. (Refer to Section V for load factor limits.)

Bank Angle Deg.	Load Factor "g's"	Bank Angle Deg.	Load Factor "g's"
0	1.000	40	1.305
5	1.004	45	1.414
10	1.015	50	1.556
15	1.035	55	1.743
20	1.064	60	2.000
25	1.103	65	2.366
30	1.155	70	2.924
35	1.211		

APPENDIX I
PART I

W/δ AS A FUNCTION OF GROSS WEIGHT AND ALTITUDE

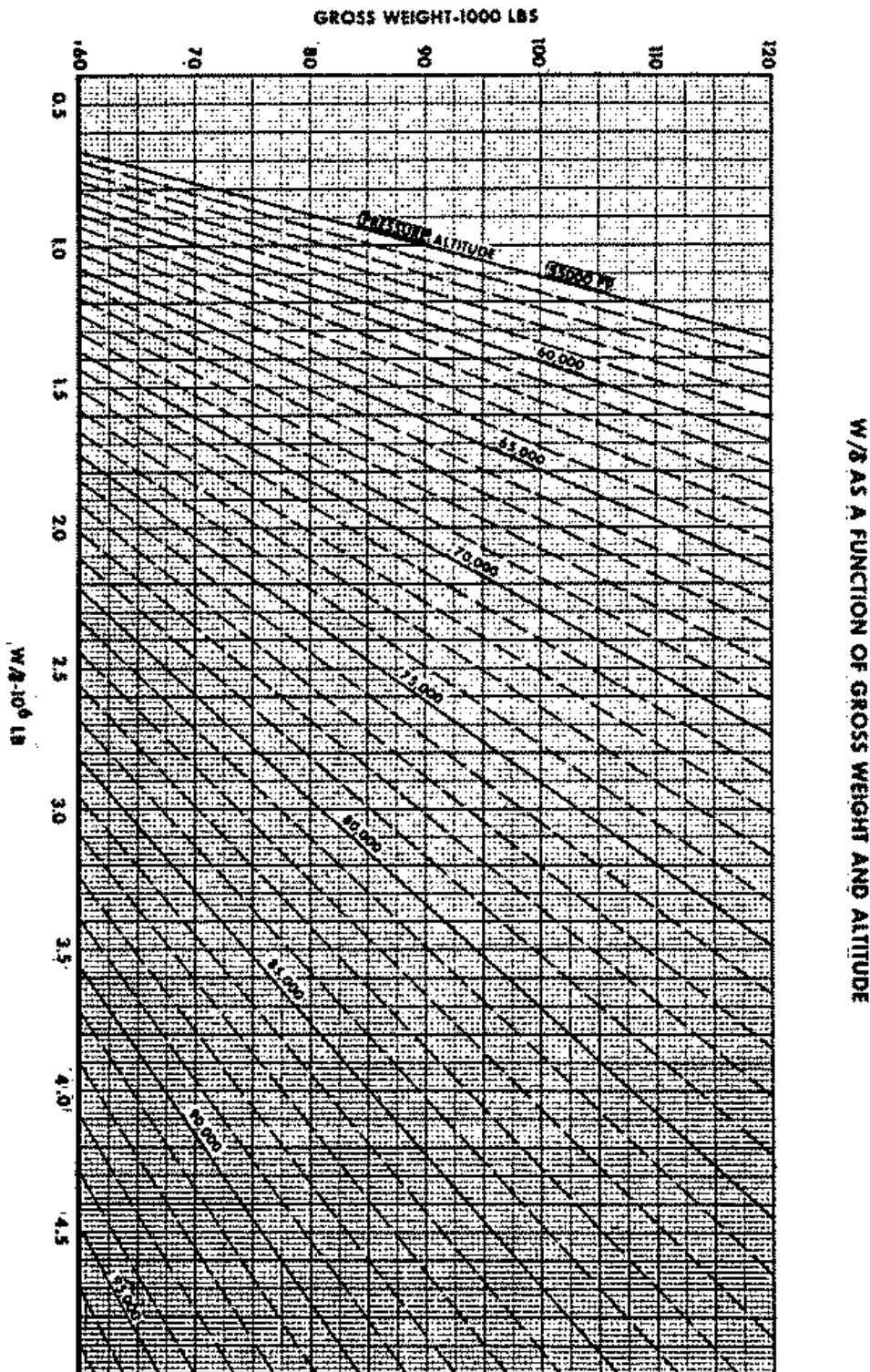


Figure A1-12

TYPICAL VARIATION OF FUEL DENSITY WITH TEMPERATURE

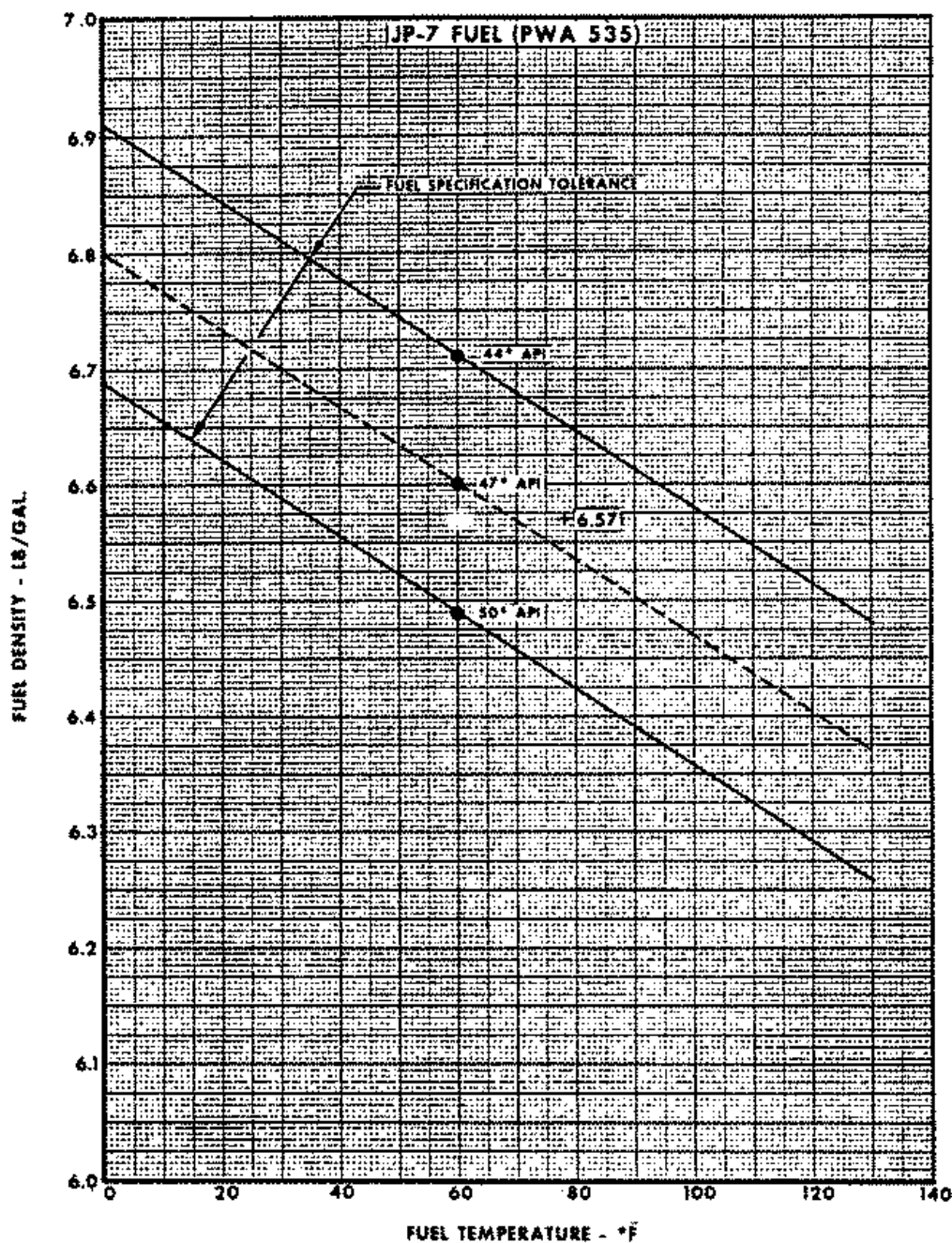


Figure A1-13

PART II

TAKEOFF AND LANDING PERFORMANCE

TABLE OF CONTENTS

	<u>Page</u>
FIELD LENGTH REQUIREMENTS	A2-2
TAKEOFF PERFORMANCE	A2-2
TAKEOFF FUEL ALLOWANCE	A2-4
ACCELERATION CHECK	A2-5
REFUSAL SPEED	A2-6
SINGLE ENGINE CLIMB CAPABILITY	A2-9
LANDING PERFORMANCE	A2-11
TAKEOFF PLANNING	A2-15/A2-16

LIST OF ILLUSTRATIONS

	<u>Figure No.</u>
Crosswind Component & Rated Tire Speed Chart	A2-1
Normal Performance Takeoff	A2-2
Takeoff Climbout Distance	A2-3
Increased Speed Takeoff Performance	A2-4
Maximum Performance Takeoff	A2-5
Acceleration Check Speed and Distance	A2-6
Refusal Speeds	A2-7 - A2-11
Single Engine Level Flight Speeds	
- In Ground Effect	A2-12
- Out of Ground Effect	A2-13
Single Engine Maximum Thrust Rate of Climb	A2-14
Approach and Landing Speed Schedules	A2-15
Landing Distance - Normal Performance	A2-16 & A2-17
Landing Distance - Maximum Performance	A2-18 - A2-21
Landing Air Distance	A2-22

APPENDIX I PART II

FIELD LENGTH REQUIREMENTS

This part of the appendix contains data for determining takeoff and landing field length requirements. Charts are also included for computing takeoff acceleration check speed, refusal speed, single-engine climbout capability, and final approach and touchdown speeds. Temperature, altitude, gross weight, wind, and runway slope corrections are included. Braking performance on dry or wet, grooved or ungrooved runways is provided.

NOTE

Refusal speed and landing distance information is conservative when the ambient temperature is hotter than 32°C (90°F) because it does not reflect Pratt and Whitney EC 173960 which decreased J-58 idle rpm to 3975 above 32°C.

Crosswind Component & Rated Tire Speed Chart

The upper part of Figure A2-1 is used to convert wind velocity and direction into runway and crosswind components. The lower portion of the chart is used to determine whether takeoff and landing speeds will exceed rated tire speed.

TAKEOFF PERFORMANCE

Charts are furnished for normal, alternate (maximum speed), and maximum performance (minimum distance) takeoff procedures. Takeoff climbout distances are included for normal performance takeoffs. The information supplied by the charts is supplied in the Pilot's and RSO's checklists.

Normal Performance Takeoff

Normal performance takeoff distances are based on rotation at 180 KIAS and liftoff at 210 KIAS. Rotation at speeds slightly less

than 180 KIAS have no appreciable effect on takeoff distance. However, at light weights the 210 KIAS takeoff speed may be exceeded if rotation is not begun before 180 KIAS.

NOTE

Do not exceed this alternate takeoff speed schedule (tire speed limitation).

When the normal performance takeoff procedure requires excessive runway length, rotation and takeoff speeds may be reduced equally by one knot for each percent reduction in takeoff distance desired. Reduce takeoff distance 1% for each knot reduction in takeoff speed.

NOTE

Do not reduce takeoff speed below the maximum performance takeoff speed schedule.

Figure A2-2 shows the ground run distance associated with the normal performance takeoff speed.

Takeoff Climbout Distance

Figure A2-3 shows the distance from liftoff to heights of 50 feet and 200 feet above the runway when using the normal performance takeoff procedure.

Example:

For a field pressure altitude of sea level, ambient temperature of 86°F (30°C), and a takeoff gross weight of 120,000 lb, determine the normal performance takeoff distance with a 10 knot headwind and 1% downhill runway slope. Refer to Figures A2-2 and A2-3. (Takeoff distance with predicted wind and slope is 4800 feet. The distances from liftoff to 50 feet and 200 feet above the runway are 3050 feet and 5500 feet, respectively. Total distance to 50 feet is 7850 feet, and to 200 feet is 10,300 feet.)

Alternate (Maximum Speed) Takeoff

The alternate (maximum speed) takeoff procedure provides a takeoff speed schedule which will not exceed rated tire speed under high altitude, high temperature conditions and/or with tailwinds. The normal rotation speed (180 KIAS) is not changed but liftoff speed corresponds to 234 knots groundspeed (rated tire speed minus 5 knots).

NOTE

When using this procedure it is important to unload the main gear tires by starting rotation at the normal schedule.

Local altitude, temperature, and steady headwind component or gusting tailwind component should be considered when using this procedure.

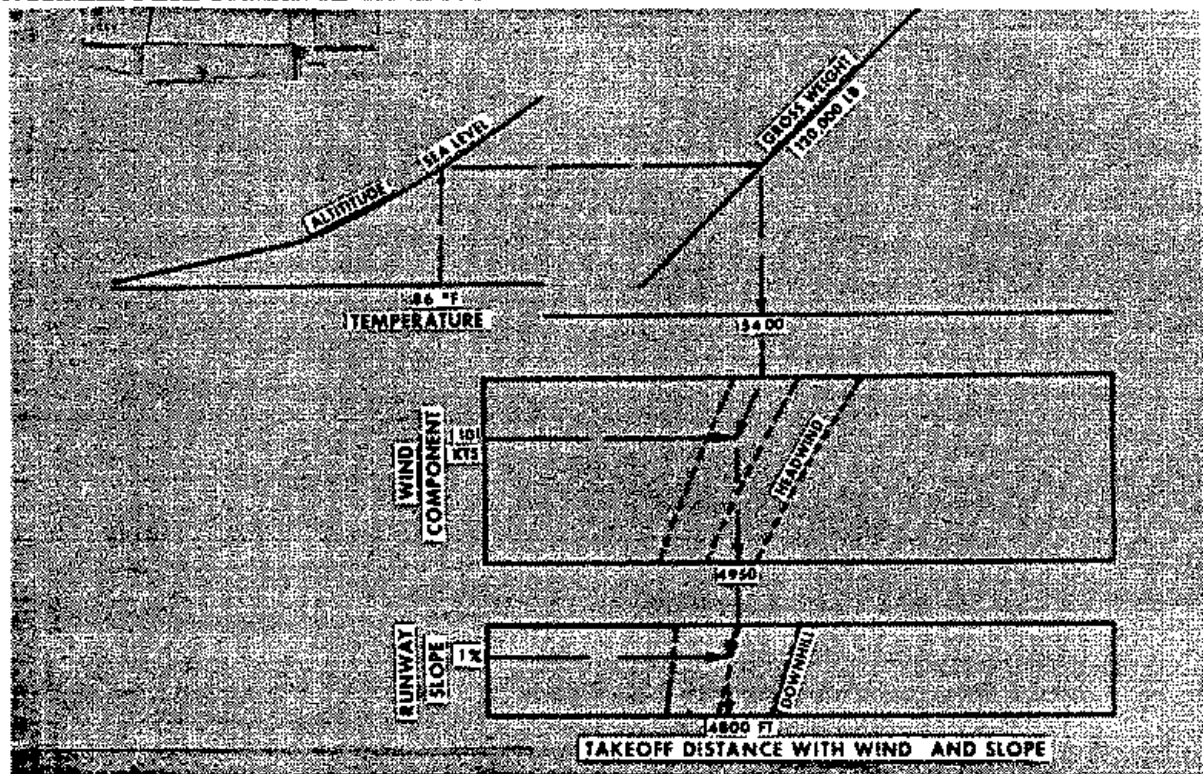
Example:

For the normal performance takeoff example, find the takeoff speed and distance for an alternate procedure takeoff. Refer to Figure A2-4. (Takeoff speed is 237 KIAS. Takeoff distance is 6250 feet.)

Maximum Performance (Minimum Distance) Takeoff

For the maximum performance (minimum distance) takeoff procedure, takeoff speed is scheduled according to gross weight and corresponds to a lift coefficient of 0.60. Since tail clearance at lift-off will be at a minimum, this procedure is recommended only when required by field length and/or tailwind conditions.

Figure A2-5 presents maximum performance takeoff distances. Takeoff speeds are listed with the corresponding gross weights. Rotation speeds are also shown, based on 4.5 seconds from rotation to lift-off.

NORMAL PERFORMANCE TAKEOFF

LANDING DISTANCE

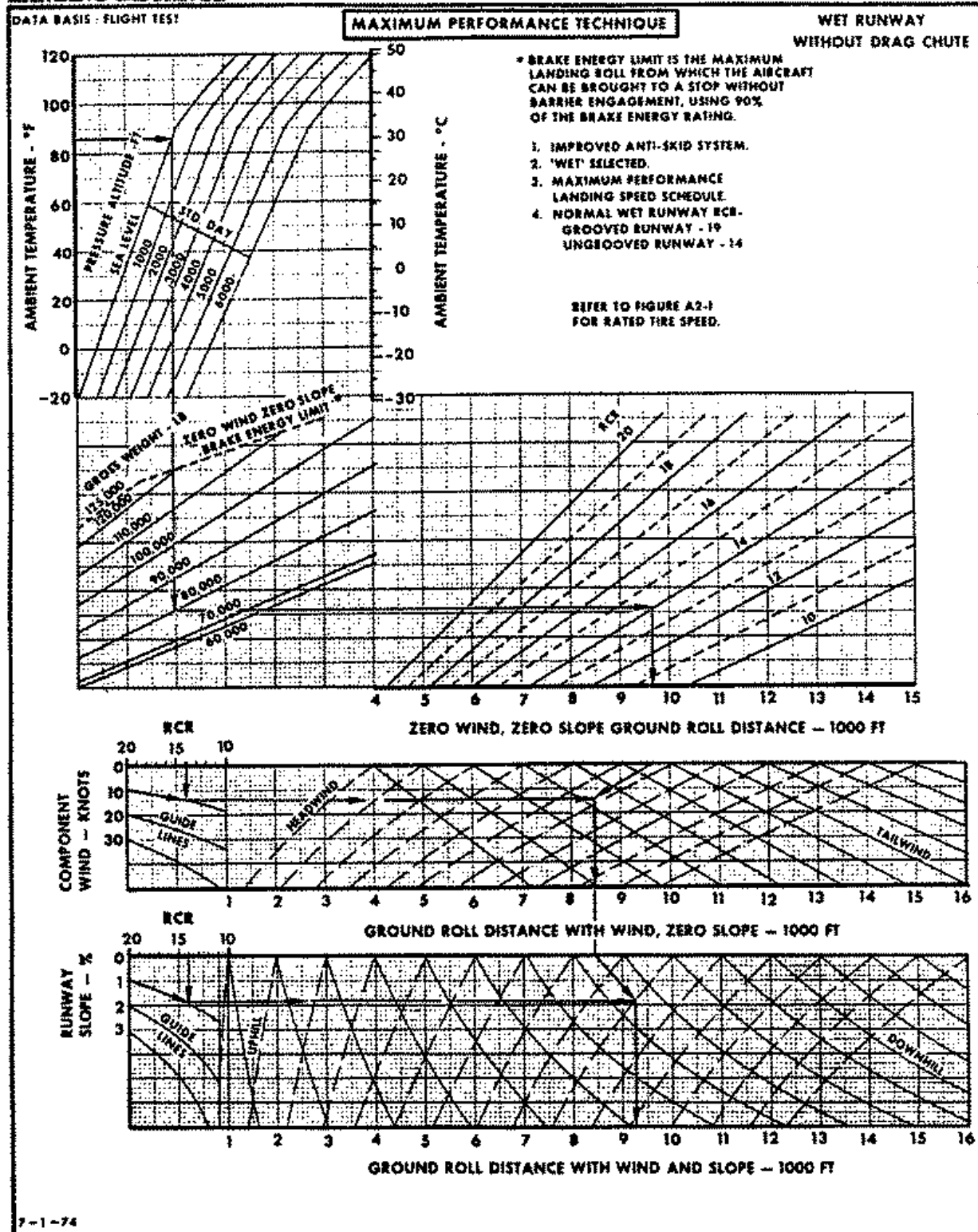
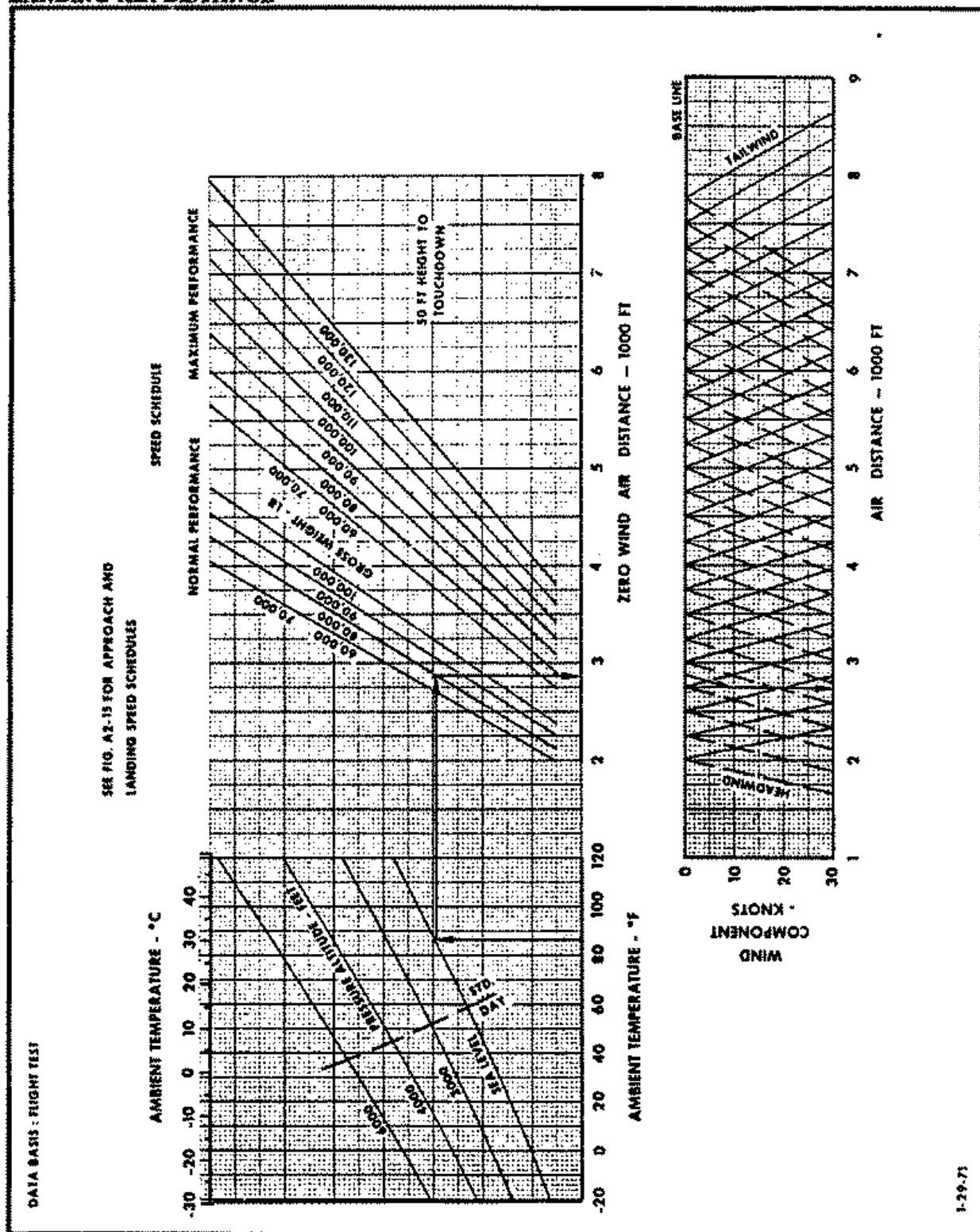


Figure A2-21

APPENDIX I
PART II

SR-71A-1

LANDING AIR DISTANCE



PART IIICLIMB AND DESCENT PERFORMANCETABLE OF CONTENTS

	<u>Page</u>
CLIMB AND DESCENT	A3-2
NORMAL CLIMB	A3-3
400 KEAS CLIMB	A3-3
SINGLE ENGINE CLIMB	A3-3
NORMAL DESCENT	A3-4
SINGLE-ENGINE DESCENT	A3-5

LIST OF ILLUSTRATIONS

	<u>Figure No.</u>
Subsonic Climb Performance	
Two Engines - Standard Day + 10°C	A3-1
Two Engines - Tropic Day + 10°C	A3-2
One Engine - Standard Day + 10°C	A3-3
One Engine - Tropic Day + 10°C	A3-4
Transonic Acceleration Performance	
Climb and Descent	A3-5
Level Acceleration	A3-6
Level Acceleration and Climb	A3-7
Comparison of Techniques at 140,000 lb Gr. Wt.	A3-8
Normal Procedure Climb Performance from Brake Release	
Standard Day	A3-9
Tropic Day	A3-10
Normal Procedure Climb Performance from 1.25 Mach at 30,000 Ft	
Standard Day	A3-11
Standard + 10°C	A3-12
Standard - 10°C	A3-13
Tropic Day	A3-14
Tropic + 10°C	A3-15
Tropic - 10°C	A3-16
Profile Climb Performance at 400 KEAS	A3-17
Normal Descent Performances - Two Engines	
720°C EGT/6900 rpm	A3-18
Military/6900 rpm	A3-19
Military/720°C EGT	A3-20
Turning Descent Performance - Two Engines - 720°C EGT/6900 rpm	A3-21
Single Engine Descent Performance	
Maximum A/B	A3-22
Minimum A/B	A3-23
Turning Descent Performance - One Engine - Maximum A/B	A3-24

APPENDIX I
PART III

CLIMB AND DESCENT DATA

This part of the appendix contains planning information for the climb and descent portions of a mission. Charts are provided for the normal 450 KEAS supersonic climb schedule and for the 350 KEAS descent. Additional information is provided for an alternate 400 KEAS supersonic climb, for single engine subsonic climbs, and for single engine supersonic descents.

NORMAL CLIMB

Time, fuel and distance requirements for the normal 450 KEAS climb schedule are shown in Figures A3-1 through A3-16. Allowances are tabulated on Figure A3-1 and A3-2 for ground operation, for takeoff at altitudes other than Sea Level, and for climb after refueling. Figures A3-9 and A3-10 summarize normal climb acceleration performance from brake release for a standard day and tropic day, respectively. A normal operating range of gross weights is presented.

Subsonic Climb Performance

Figures A3-1 and A3-2 provide two engine climb performance from brake release at Sea Level to Mach 0.90 at 30,000 feet for standard and tropic atmospheres, respectively. The data can be used on an incremental basis for climbs between other altitudes in this range. Performance is supplied for initial gross weights from 90,000 pounds to 140,000 pounds. Correction grids are provided for temperature deviations of $\pm 10^{\circ}\text{C}$.

Transonic Acceleration Performance

Figures A3-2 through A3-8 show the time, distance, and fuel required for transonic acceleration. Performance is supplied for initial gross weights from 90,000 pounds to 140,000 pounds at temperatures ranging $\pm 10^{\circ}\text{C}$ from the standard and tropic atmospheres. The charts also provide total time, distance and fuel required to accelerate to Mach 1.25 at 30,000 feet after

Sample Use of Charts

Determine the time, fuel, and distance required for a standard day climb from sea level takeoff to Mach 3.0 at 70,600 feet. Gross weight at engine start is 136,800 pounds.

<u>Segment</u>	<u>Time</u>	<u>Fuel Used</u>	<u>Distance</u>	<u>End Weight</u>
Start Engines	0	0	0	136,800
Ground Maneuver (150 lb/min)	(0:20)	<u>3,000</u> 3,000	0	133,800
Climb to 30,000 feet (Figure A3-1) Std Day	<u>0:04.6</u> 0:04.6	<u>6,400</u> 9,400	<u>34</u> 34	127,400
Accel to Mach 1.25 (Figure A3-5) Std Day	<u>0:02.2</u> 0:06.8	<u>3,000</u> 12,400	<u>22</u> 56	124,400
Climb to 70,600 feet (Mach 3.0, 410 KEAS (Figure A3-11))	<u>0:13.1</u> 0:19.9	<u>17,300</u> 29,700	<u>272</u> 328	107,100
	Min.	Lb.	NMi	Lb.

refueling at Mach 0.75 and 25,000 feet. The added allowances are based on the use of minimum afterburner for the subsonic acceleration, or for acceleration and climb to the initiation of maximum afterburner power at Mach 0.90.

Performance charts are included for three types of maximum power acceleration techniques.

1. Climb-and-descent: Climb at Mach 0.90 from 30,000 feet to 33,000 feet, and then descend at 3000 fpm to Mach 1.25 at 30,000 feet. (See Figure A3-5.)
2. Level acceleration: Accelerate from Mach 0.90 to Mach 1.25 at 30,000 feet. (See Figure A3-6.)
3. Level acceleration and climb: Accelerate from Mach 0.90 to 450 KEAS at 25,000 feet and climb at 450 KEAS to Mach 1.25 at 30,000 feet. (See Figure A3-7.)

Figure A3-8 presents a performance comparison of the transonic acceleration techniques for an initial gross weight of 140,000 pounds at Mach 0.75 and 25,000 feet. The chart illustrates the effect of ambient temperature and shows that at ambient temperatures below standard, all three techniques have similar fuel consumption but the climb-and-descent technique improves range since more distance is covered for the same fuel consumption. At temperatures hotter than standard, the climb-and-descent technique reduces fuel consumed 700 to 900 pounds in a tropic atmosphere (approximately 13°C hotter than standard between 25,000 feet and 30,000 feet), and as much as 1300 to 1900 pounds at a temperature deviation 22°C hotter than standard.

Any necessary heading changes should be made prior to the transonic acceleration, as turns would seriously degrade performance during this phase. A 32° banked turn at 25,000 feet, initiated between Mach 0.75 and

0.80 at 140,000 pounds will increase time, distance, and fuel used by 0.5 minutes, 5 nautical miles, and 500 pounds, respectively, for a ninety degree change in aircraft heading.

Supersonic Acceleration & Climb

Performance for the supersonic climbing acceleration is provided by Figures A3-11 through A3-16. Data is provided for standard and tropic atmospheres including temperature deviations of +10°C. Enter the chart with the end-of-transonic acceleration weight determined from Figures A3-5 through A3-8.

When a constant Mach climb is required to reach cruise altitude after attaining the desired Mach, climb at Maximum afterburning power. For planning purposes, 4000 ft/min rate of climb and 900 pounds/minute fuel flow.

400 KEAS CLIMB

Figure A3-17 summarizes time, fuel, and distance required from takeoff for an alternate, 400 KEAS supersonic climb schedule at a nominal takeoff gross weight of 130,000 lb.

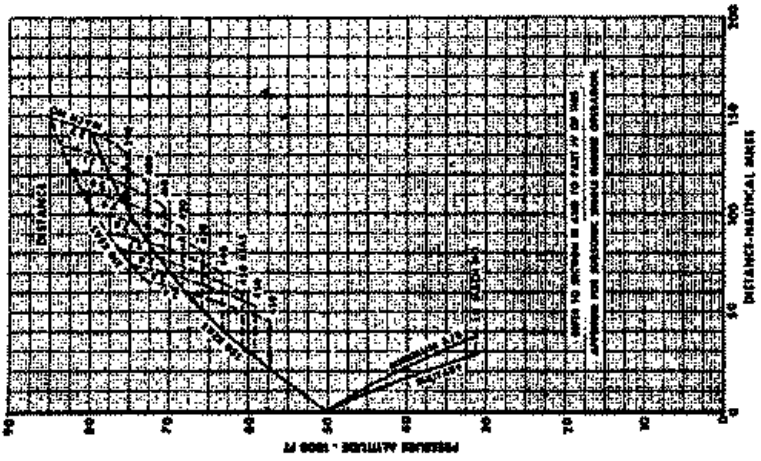
SINGLE-ENGINE CLIMB

Figures A3-3 and A3-4 show the time, fuel, and distance requirements for single engine climb from sea level to the altitudes at which 300 ft/min rate of climb is reached. Performance is shown for Standard and Tropic days, respectively. These charts can be used on an incremental basis to determine requirements for climbing to single engine cruise altitudes. (See Part IV of this appendix and Section III.) The data are based on Maximum afterburning climb at 400 KEAS to Mach 0.85, then Mach 0.85 to the 300 ft/min ceiling. (If the climb is continued above this ceiling, a cruise-climb at 200-250 ft/min rate of climb will result.)

SINGLE-ENGINE DESCENT PERFORMANCE

9418 (Rev. 1-67)

ENGINE CONFIGURATION			
ENGINE	THROTTLE	WING	AT 5/7
OPERATION	100%	100%	100%
DESCRIPTION	100%	100%	100%
REMARKS	100%	100%	100%



SR-71A-1

APPENDIX I
PART III

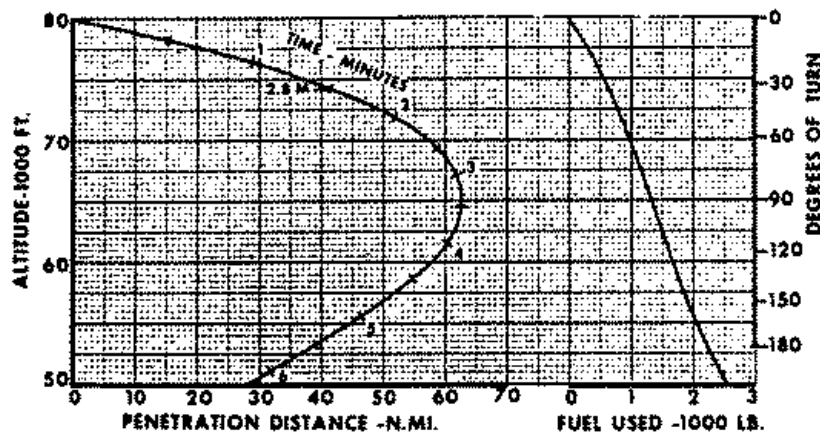
SINGLE-ENGINE TURNING DESCENT

DATA BASIS: CALCULATION

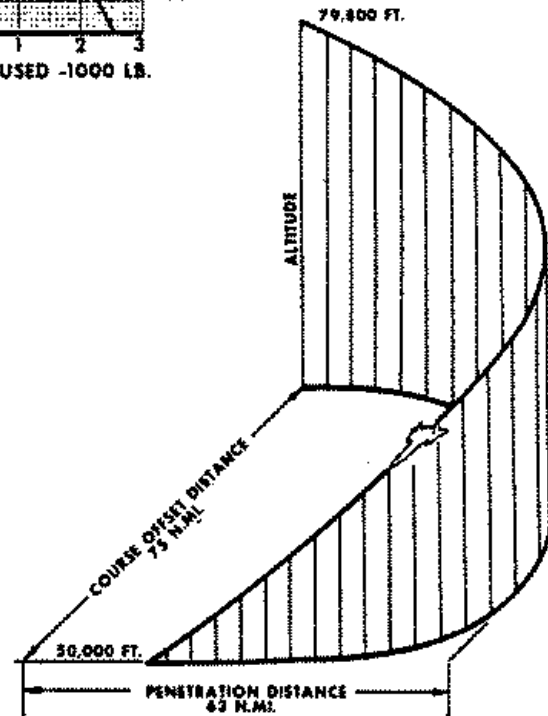
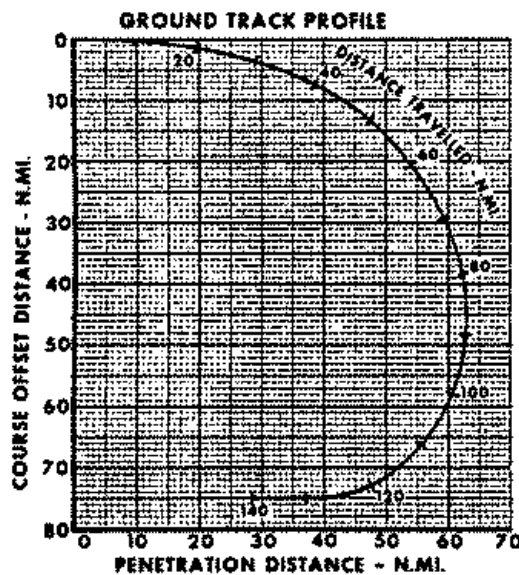
350 KEAS
MAXIMUM A/S
79,800 FT. TO 50,000 FT.
35°BANK-180° TURN

80,000 LB. INITIAL GROSS WEIGHT
STANDARD DAY 22% C.G.

INLET CONFIGURATION			
ENGINE	SPIKE	FWD B/P	AFT B/P
OPERATING	AUTO	AUTO	CLOSED
WINDMILLING	FWD TO M 2.8 AFT M 2.8 TO M 1.5	FULL OPEN	FULL OPEN



TURNING DESCENT PROFILE



1-29-71

Figure A3-24

A3-35/A3-36 Blank)

PART IV

SUBSONIC CRUISE PERFORMANCE

TABLE OF CONTENTS

	<u>Page</u>
SPECIFIC RANGE - TWO ENGINES	A4-2
SUBSONIC MAXIMUM RANGE CRUISE - CLIMB	A4-2
RANGE FACTOR SUMMARY & MAX SPECIFIC RANGE	A4-2
BUDDY MISSION AT MACH 0.75	A4-2
LOITER PERFORMANCE	A4-3
SUBSONIC MISSION PROFILE	A4-3
SINGLE-ENGINE SPECIFIC RANGE	A4-3

LIST OF ILLUSTRATIONS

	<u>Figure No.</u>
Subsonic Specific Range - Two Engines	
Sea Level	A4-1
5,000 Feet	A4-2
10,000 Feet	A4-3
15,000 Feet	A4-4
20,000 Feet	A4-5
22,000 Feet	A4-6
24,000 Feet	A4-7
25,000 Feet	A4-8
26,000 Feet	A4-9
28,000 Feet	A4-10
30,000 Feet	A4-11
32,000 Feet	A4-12
34,000 Feet	A4-13
35,000 Feet	A4-14
36,000 Feet	A4-15
38,000 Feet	A4-16
40,000 Feet	A4-17
Subsonic Maximum Range Cruise - Climb	A4-18
Subsonic Range Factor	A4-19
Maximum Specific Range	A4-20
Constant Mach Cruise (Mach 0.75)	A4-21
Loiter Performance	A4-22, A4-23
Subsonic Mission Profile	A4-24
Subsonic Single-Engine Specific Range	
Military Thrust	A4-25
Minimum Afterburner Thrust	A4-26
Maximum Afterburner Thrust	A4-27

APPENDIX I PART IV

SPECIFIC RANGE - TWO ENGINE

Specific Range vs Mach for two engine operation is shown in Figures A4-1 thru A4-17 for altitudes from Sea Level to 40,000 ft. All performance information has been corrected to a c.g. of 22% MAC. Operation at c.g. positions forward of 22% reduces range approximately 1% for each percent c.g. shift, as noted on the specific range curves. The curves show performance for the operational range of gross weights at each altitude and cover the speed range from maximum endurance to Military thrust. Subcales of equivalent airspeed and calibrated airspeed are provided. The recommended loiter speed schedule is included for each altitude.

NOTE

The subsonic minimum airspeed restriction of 300 KEAS above 25,000 feet has been observed in all performance presented except the specific range curves.

SUBSONIC MAXIMUM RANGE CRUISE-CLIMB

Figure A4-18 shows the range available by cruise-climbing at Mach 0.88 and at 380,000 lb W/δ . The curve is indexed to an end-of-cruise gross weight of 70,000 lbs (approximately 10,000 lb of fuel remaining) as a convenience in flight planning. (10,000 lbs is an arbitrary fuel remaining value and is not mandatory for termination of cruise.) The curve can also be used on an incremental basis for any desired start and end cruise condition.

Example:

For a gross weight of 90,000 lbs (approx. 30,000 lbs of fuel remaining) determine the distance remaining to 70,000 lbs gross weight and distance flown between 90,000 lbs gross weight and 80,000 lbs gross weight. Enter

Figure A4-18 at 90,000 lbs gross weight and read the distance to 70,000 lbs directly as 725 nautical miles. At 80,000 lbs read the distance to 70,000 lbs as 375 nautical miles. The distance flown between 90,000 lbs and 80,000 lbs is (725-375) or 350 nautical miles. Cruise at 32,400 feet.

An additional 190 nautical miles is available by ending cruise at 65,000 lbs gross weight (approximately 5000 lbs of fuel remaining).

RANGE FACTOR SUMMARY

The Range Factor Summary shown in Figure A4-19 defines the maximum specific range capability in terms of the gross weight/altitude parameter, W/δ . The Mach schedule required to obtain this performance is shown on the lower portion of the curve. The curve covers the complete operating weight and power range of the airplane, up to and including Military thrust. Maximum range capability (cruise-climb) is obtained at a W/δ of 380,000 lb and at Mach 0.88.

Figure A4-20 depicts the information given by the Range Factor Summary in terms of Maximum Specific Range as a function of gross weight and altitude.

BUDDY MISSION AT MACH 0.75

The buddy mission schedule, Mach 0.75, is based on performance compatibility with KC-135 tanker aircraft. Figure A4-21 shows the specific range available in cruise-climb or at constant altitude with constant Mach 0.75 cruise speed. Greater range capability is obtained by cruise-climbing.

Example:

Determine the range available at 24,000 ft at an initial gross weight of 90,000 lb if 10,000 lbs of fuel is to be consumed. Enter Figure A4-21 at 90,000 lbs at 24,000 ft and read the specific range available as 28.5 nautical miles per 1000 lbs of fuel. At 80,000 lb and 24,000 ft read the specific range as 29.7 nautical miles per 1000 lbs of fuel. The

average specific range is 29.1 nautical miles per 1000 lbs and the range available for 10,000 lbs of fuel consumed is 291 nautical miles.

LOITER PERFORMANCE

Figure A4-22 presents loiter performance in terms of minutes per 1000 lbs of fuel consumed. A loiter profile in Figure A4-23 provides time available from various initial fuel remaining values to 10,000 pounds remaining. (70,000 lb gross weight). The profile is keyed to the same speed schedule as the specific endurance chart.

Example:

Determine the loiter time available at 20,000 ft at an initial gross weight of 90,000 lbs if 10,000 lbs of fuel is to be consumed. Enter Figure A4-22 at 90,000 lbs gross weight and 20,000 ft and read loiter time available as 3.75 minutes per 1000 lbs of fuel. At 80,000 lbs and 20,000 ft read 4.01 minutes per 1000 lbs of fuel. The average loiter time available is 3.9 minutes per 1000 lbs of fuel or 39 minutes for 10,000 lbs of fuel.

SUBSONIC MISSION PROFILE

Figure A4-24 presents the constant altitude, cruise climb, and Military thrust range in terms of distance to go to 70,000 lbs gross weight (approximately 10,000 lbs of fuel remaining). The curve may also be used on an incremental basis.

Cruise speeds for constant altitude cruise are tabulated on the chart. Climb performance tables are also provided which apply to

takeoff (brake release) at nominal gross weights of 140,000, 120,000, and 100,000 lb. The climb data are based on Maximum thrust takeoff with power reduction to Minimum afterburning following gear retraction.

Example:

Determine the range available at an initial gross weight of 125,000 lbs if cruise is to be terminated at 10,000 lbs remaining (approximately 70,000 lbs gross weight). Figure A4-24 shows that by cruising at 25,000 feet at an initial gross weight of 125,000 lbs the range will be 1554 nautical miles to 10,000 lbs of fuel remaining. This range increases to 1703 nautical miles by cruising at 30,000 feet. Maximum range is available by cruise climbing at Mach 0.88. Under this condition cruise would be initiated at 27,700 feet to 300 KEAS at 32,400 feet and constant altitude cruise to 10,000 lbs remaining. Distance traveled would be 1746 nautical miles.

SINGLE-ENGINE SPECIFIC RANGE

Specific range vs Mach for one engine operation at Military, Minimum A/B and Maximum A/B thrust is presented in Figures A4-25 through A4-27. The cruise altitudes are single engine ceiling capabilities with corresponding nautical miles per 1000 pounds of fuel. The optimum cruise Mach is included for each thrust setting.

Refer to Section III, Emergency Procedures, for single engine maximum range capabilities at each throttle setting to 5000 pounds of fuel remaining.

APPENDIX I
PART IV

SR-71A-1

SUBSONIC SINGLE-ENGINE SPECIFIC RANGE - MINIMUM A/B

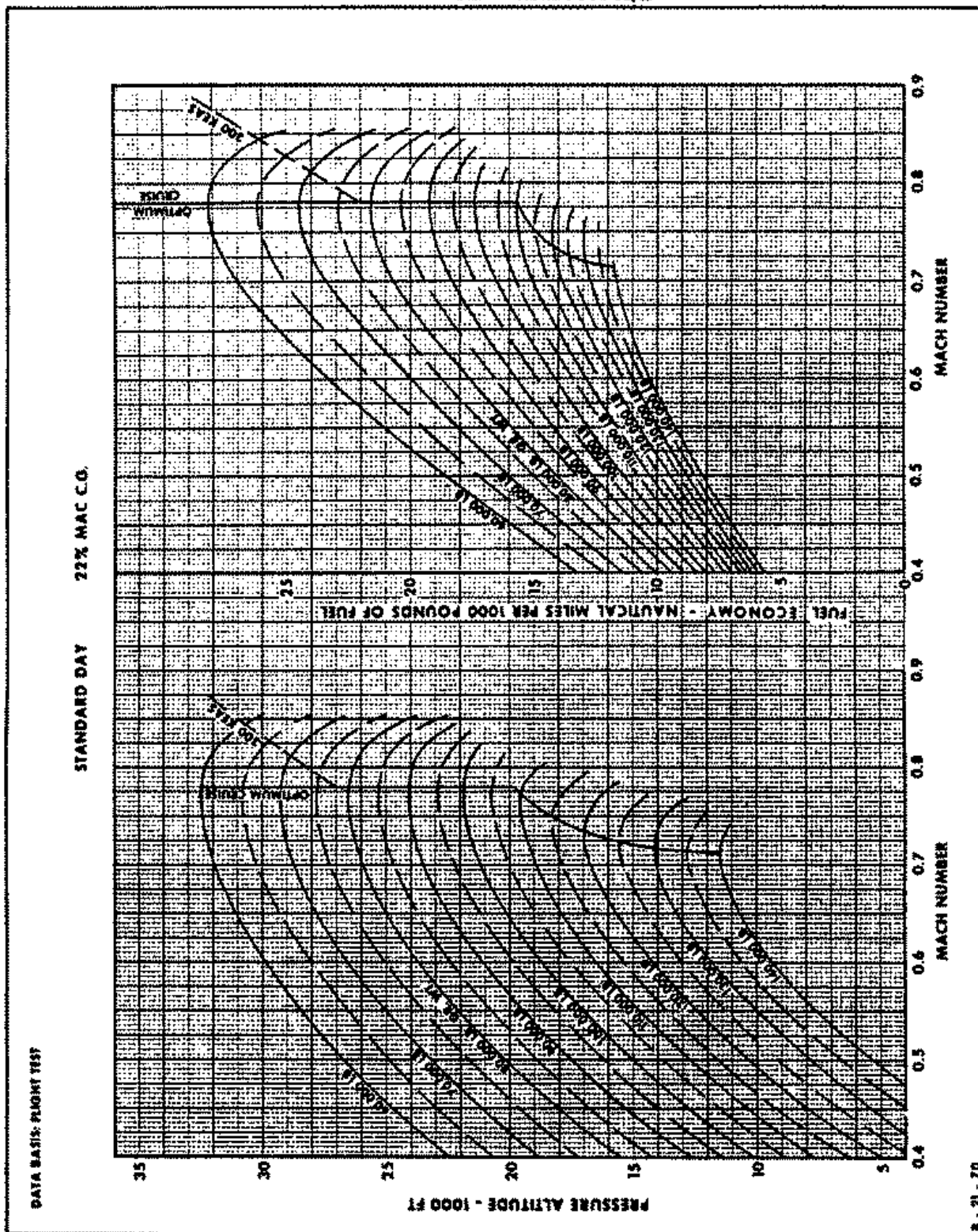


Figure A4-26

SUBSONIC SINGLE-ENGINE SPECIFIC RANGE - MAXIMUM A/B

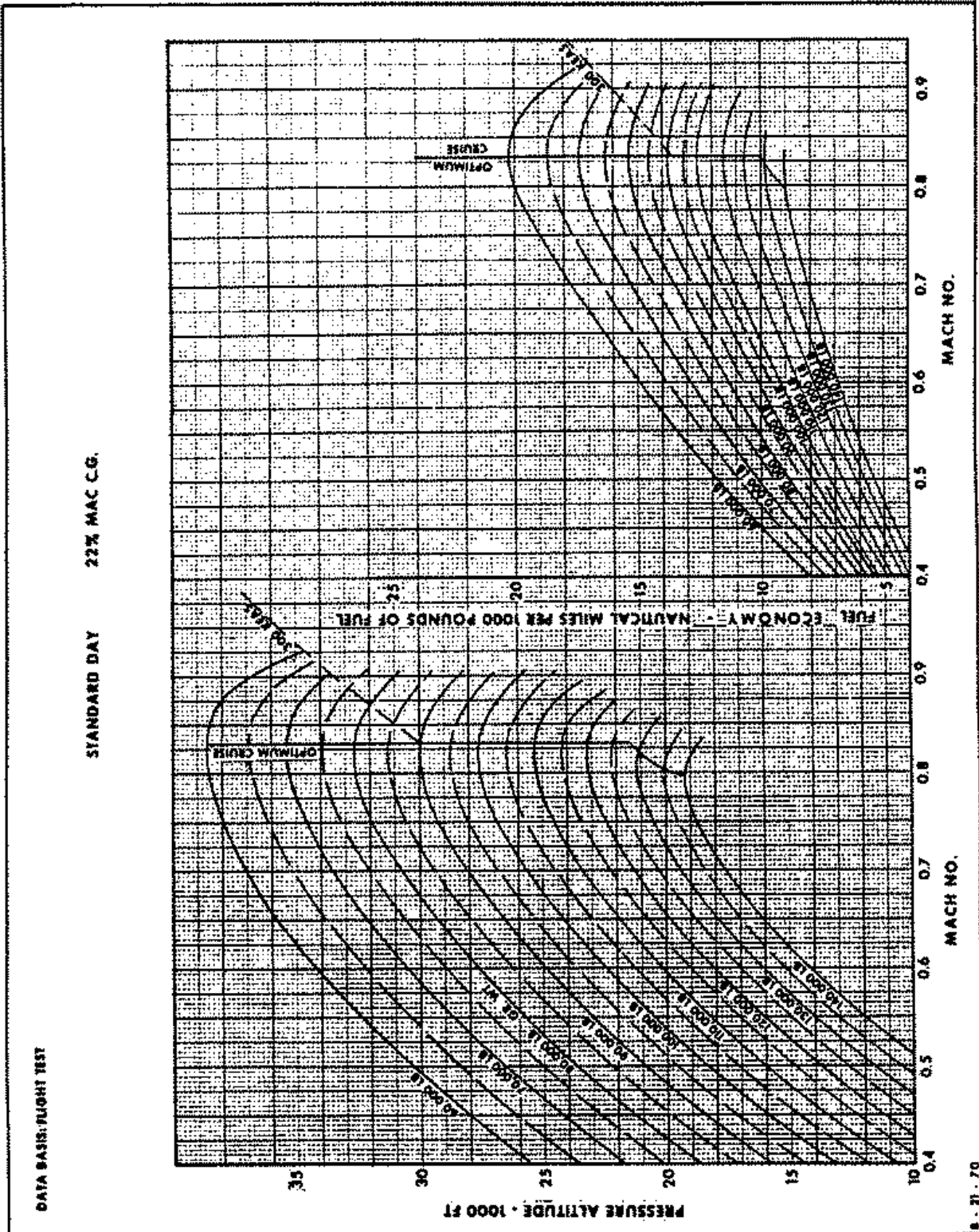


Figure A4-27


SH-71A-1

APPENDIX I
PART V

PART V

SUPERSONIC SPECIFIC RANGE DATA

TABLE OF CONTENTS

	<u>Page</u>
SPECIFIC RANGE	A5-2
RANGE FACTOR PARAMETER	A5-2

LIST OF ILLUSTRATIONS

	<u>Figure No.</u>
SPECIFIC RANGE - RANGE FACTOR:	
Mach 3.20	A5-1 thru A5-12
Mach 3.15	A5-13 thru A5-26
Mach 3.10	A5-27 thru A5-36
Mach 3.00	A5-37 thru A5-46
Mach 2.80	A5-47 thru A5-56
Mach 2.40	A5-57, A5-58

APPENDIX I
PART V

SPECIFIC RANGE

Specific range curves are provided for cruise speeds of Mach 3.20, 3.15, 3.10, 3.00, 2.80 and 2.40 and for a range of temperatures at each cruise speed except Mach 2.40. Data is presented for the operational range of gross weights and altitudes available at afterburning power settings, including Maximum afterburning. Correction grids show the effects of bank angle on specific range and altitude during turns at constant power settings. Supplemental scales provide KEAS-altitude information and convert nautical miles per 1000 lb (nmi/1000 lb) to fuel flow.

Example:

At Mach 3.20, with a CIT of 380°C (-56.5°C FAT) (Figure A5-5), the maximum specific range at a gross weight of 90,000 lb is 54.1 nm/1000 lb of fuel at an altitude of 78,700 feet. For a 30° banked turn, maximum range altitude decreases to 75,700 feet and specific range decreases to 46.8 nm/1000 lb of fuel. Fuel flow per engine is 16,900 lb/hr at maximum range and increases to 19,700 lb/hr in a 30° banked turn at the lower altitude. For the same gross weight at a CIT of 370°C (Figure A5-3) the maximum specific range is 55.0 nm/1000 lb of fuel at an altitude of 79,000 feet while an increase in CIT to 390°C (Figure A5-8) only decreases specific range to 54.0 nm/1000 lb but altitude decreases to 78,400 feet.

RANGE FACTOR PARAMETER

The Range Factor Parameter curves show the range capability of the aircraft in terms of Range Factor and the weight/altitude parameter, W/δ . The W/δ for maximum range is noted on the upper portion of the curves, while the lower portion of the curves provides the corresponding gross weight-altitude-KEAS relationship. A correction grid is supplied for determining Range Factor at c.g. positions other than 25%.

Range Factor is a measure of cruise performance. Range Factor is defined as

$$\text{Range Factor} = (\text{gross weight}) \times (\text{specific range})$$

The specific range at any point during cruising flight may be determined by using the definition of range factor, since

$$\text{nm}/1000 \text{ lb} = \frac{\text{R.F.}}{\text{G.W.}} \times 1000$$

Range Factor does not change as rapidly as specific range during cruising flight. Typical range factors for a particular flight schedule can be used during flight to forecast miles per pound as fuel is used. Since specific range is also defined as

$$\text{Specific Range} = \frac{\text{KTAS}}{\text{Total fuel flow}}$$

then, during cruising flight, the fuel flow per engine at any given moment is

$$\text{Fuel flow/engine} = \frac{\text{KTAS} \times \text{gross wt}}{2 \times \text{R.F.}}$$

Example:

At Mach 3.20, with 1835 KTAS, 100,000 lb gross weight, and 4940 R.F.

$$\text{Specific Range} = \frac{4940}{100,000} \times 1000 = 49.4 \text{ nm}/1000 \text{ lb.}$$

$$\text{Fuel flow/engine} = \frac{1835 \times 100,000}{2 \times 4940} = 18,600 \text{ lb/hr.}$$

For a gross weight of 80,000 lb and 4810 R.F.

$$\text{Specific Range} = \frac{4810}{80,000} \times 1000 = 60.1 \text{ nm}/1000 \text{ lb}$$

$$\text{Fuel flow/engine} = \frac{1835 \times 80,000}{2 \times 4810} = 15,250 \text{ lb/hr.}$$

SPECIFIC RANGE AT MACH 3.20

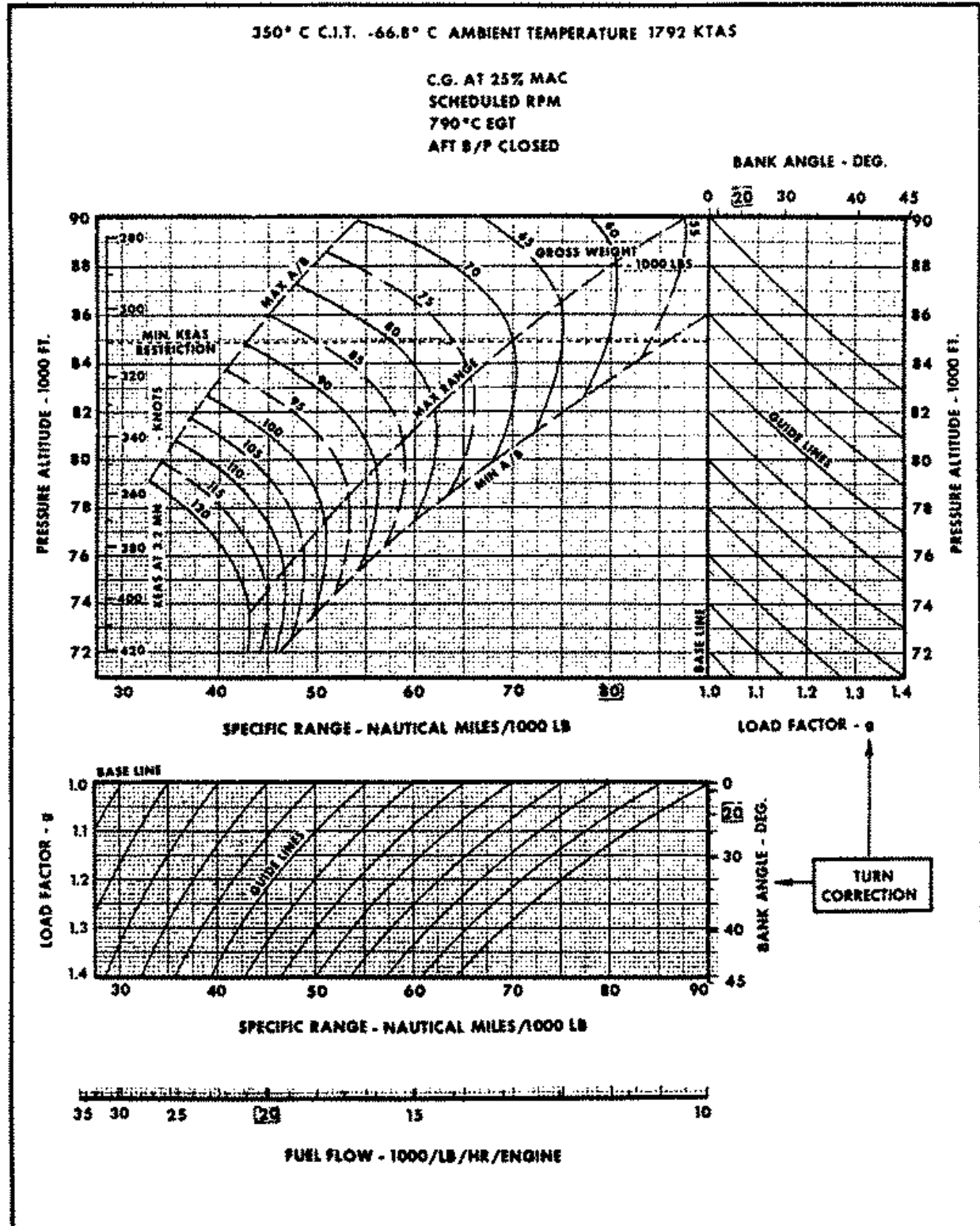


Figure A5-1

SPECIFIC RANGE AT MACH 2.40

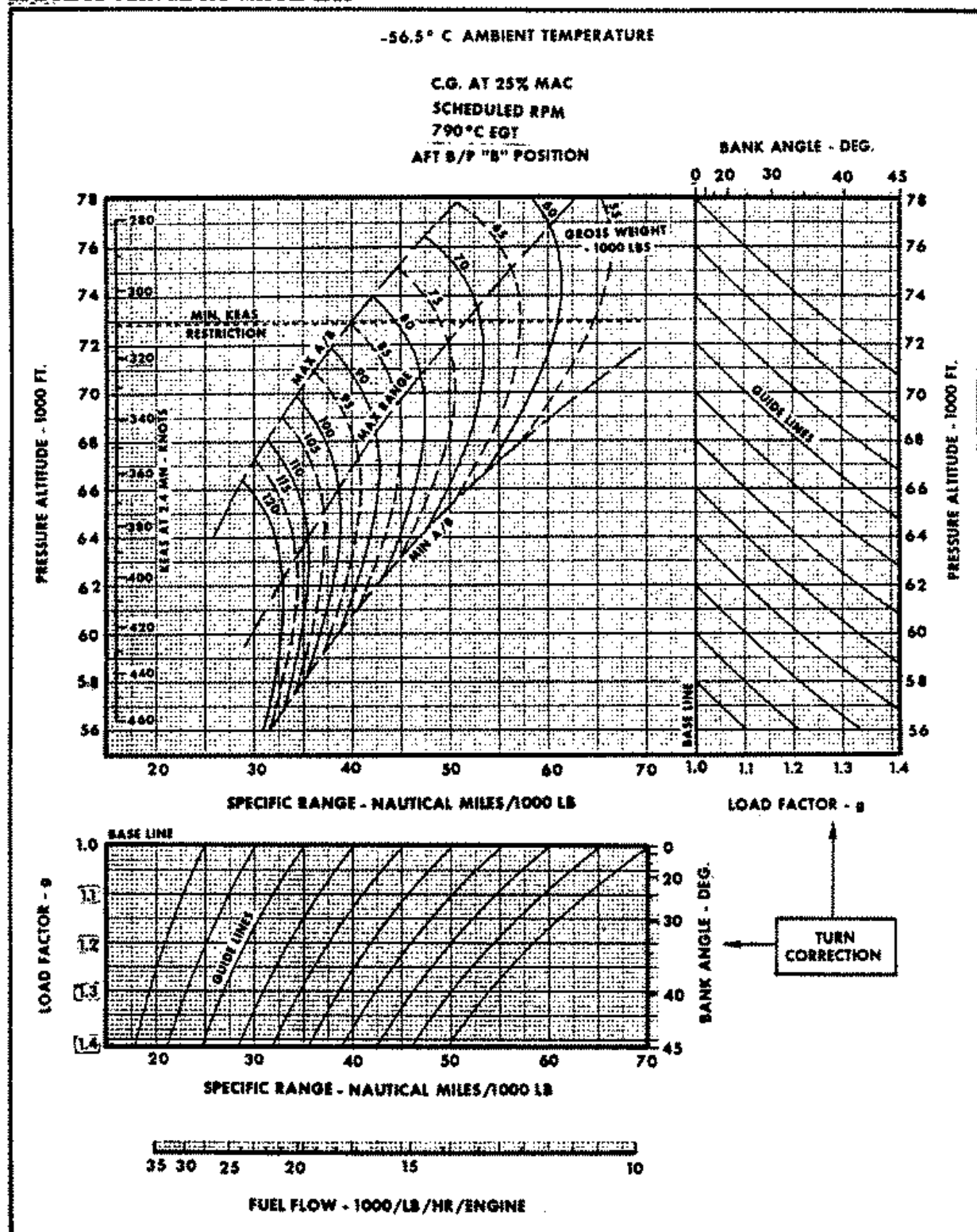


Figure A5-57

APPENDIX I
PART V

SR-71A-1

MACH 2.4 RANGE FACTOR PARAMETER

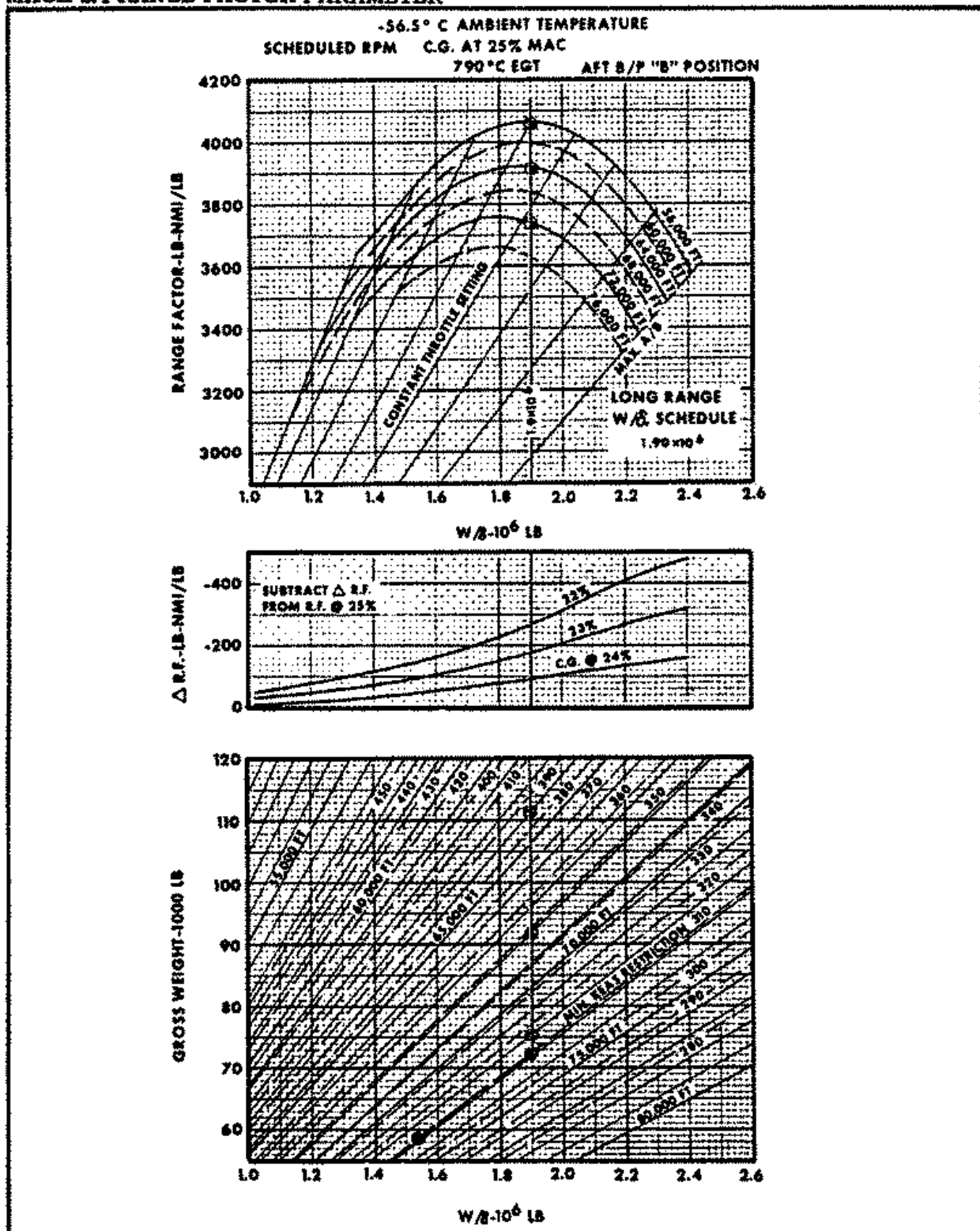


Figure A5-58

PART VI
MISSION PLANNING
TABLE OF CONTENTS

	<u>Page</u>
MISSION PLANNING	A6-2
TURNING PERFORMANCE	A6-2/A6-3
LN ₂ CONSUMPTION	A6-3

LIST OF ILLUSTRATIONS

	<u>Figure No.</u>
Cruise Summary - Mission Profile:	
Mach 3.20	A6-1 thru A6-3
Mach 3.15	A6-4 thru A6-6
Mach 3.10	A6-7 thru A6-9
Mach 3.00	A6-10 thru A6-12
Mach 2.80	A6-13
Mach 2.40	A6-14
Turning Performance	A6-15 thru A6-20

APPENDIX I
PART VI

MISSION PLANNING

The cruise speeds, altitudes and flight distances associated with the operation of this aircraft require careful planning when operating near maximum mission capability. The charts presented in parts III through V of this appendix provide the necessary performance information for many types of missions.

Several mission profiles are included to assist in mission planning. These include Maximum Range Cruise profiles for Mach 3.20, 3.15, 3.10, 3.00, 2.80, and 2.40; and Maximum Altitude and Intermediate Altitude Cruise profiles for Mach 3.20, 3.15, 3.10, and 3.00. With the exception of Mach 2.40 cruise, the effect of other than standard temperatures on cruise performance is included. The climb and descent performance shown is test performance at or near standard temperatures.

There are two sheets for each figure. The first sheet is a cruise summary of fuel and time remaining vs flight distance. These charts are indexed to 10,000 lb fuel remaining at cruise altitudes (zero distance and time).

The second sheet is a mission profile which includes climb and descent flight paths. The initial conditions are based on end AR with 78,200 lb of fuel, and brake release with either 75,200 lb or 60,000 lb fuel remaining. Plots of cruise fuel and cruise time remaining are provided. Distance and time for descent, starting at 10,000, 7500 and 5000 lb remaining, are also shown. To obtain the total distance flown from end AR or brake release to a specific fuel reserve condition, add the distances and times read from each side of the index mark for the desired profile.

Example:

Refer to Figure A6-4, sheet 2 of 2. Find the total distance and time for a 3.15 Mach long range cruise at a forecast ambient temperature of -56°C at cruise. A profile is

planned consisting of a heavy weight takeoff at sea level, normal performance climb, cruise without turns, and descent to 20,000 ft starting at 7500 lb fuel remaining. Planned fuel load at brake release is 75,200 lb fuel remaining and read distance and time as 2361 nmi, and 1 hr. 28 min. Re-enter on the 7500 lb remaining descent line at 20,000 feet and read distance and time as 442 nmi, and 21.2 min. Add the distances and times and obtain 2803 nmi and 1 hr, 49.2 min.

If forecast temperatures indicate cold day cruise conditions the distance will be increased by two increments. The cruise distance will be longer due to the colder temperature, and the climb distance will be longer due to the climb to higher altitude. Referring again to Figure A6-4, sheet 2 of 2, the shaded diamonds show where the climb intercepts the four cruise lines. For the heavy weight takeoff case the cold day intercept shows a distance of 2062 nm for a cruise at -67.5°C . Extend the climb curve (constant Mach climb) to the altitude where the cold day cruise begins and read a distance of 1999 nm. The difference between these distances ($2062 - 1999 = 63$) is the increase in range due to cold day cruise conditions. The corresponding time increment is 2.2 minutes for the additional 63 nm of cruise. This results in a total range and time of 2866 nm and 1 hr, 51.4 min.

TURNING PERFORMANCE

A generalized supersonic turn performance chart is presented in Figure A6-15. Turn radius is provided for bank angles from 10° to 45° at true airspeeds (knots) that include Mach from 2.0 to 3.2 at ambient temperatures from -40°C to -70°C . Turn distance and time are plotted for various turn radii and degrees of turn.

Maximum afterburner turn capabilities for constant Mach and altitude are presented in Figures A6-16 through A6-20. Performance is shown for various Mach, compressor inlet temperatures and bank angles from 30° to 45° . The charts also include the minimum

gross weight for pre-planning turns (various bank angles) so that the cruise Mach can be maintained without exceeding the maximum air speeds for normal operation (V_H).

These data, in conjunction with the specific range data presented in Part V of this appendix, provide sufficient information to include various turns in the mission plan.

Example:

For a turn of 180° at Mach 3.00 a forecast ambient temperature of -56.5°C and a bank angle of 30° find the turn radius, distance, and time. Enter Figure A6-15 at Mach 3.00 and -56.5°C ambient temperature and note that true airspeed is 1720 knots. Proceed horizontally to 30° bank angle and read turn radius as 74.5 nautical miles. Proceed downward to 180° of turn and read turn distance as 235 nautical miles flown.

Proceed horizontally to 1720 KTAS and read the turn time as 8.1 minutes.

LN₂ CONSUMPTION

The following table presents nominal values of LN₂ consumption which can be used for mission planning. The information is based on flight tests. In using the information for planning and for in-flight monitoring of LN₂ consumption, it should be recognized that variations from nominal values must be expected. In addition to other factors, this would be due to differences in individual flight plans and overall aircraft condition. It is suggested that the crew maintain a "how-goes-it" chart in flight to check actual LN₂ consumption against predicted consumption and to forecast LN₂ required for successive legs. It may be necessary to alter flight plans if in-flight quantity indications show premature depletion of LN₂.

NOMINAL LN₂ CONSUMPTION SCHEDULE

Boil-off before engine start	7 liters per hour
From engine start until takeoff	2 liters
For takeoff and climb to subsonic cruise altitude	1 liter
Subsonic cruise, approximately 25,000 to 30,000 feet	1/2 liter per minute
Air refueling near 25,000 feet	5 liters
Climb to supersonic cruise altitude after refueling	4 liters
Supersonic cruise, 70,000 to 85,000 feet	2 liters
Descent from supersonic cruise altitude to A/R altitude near 25,000 feet, including tanker rendezvous	16 liters
Descent from supersonic cruise altitude to approximately 20,000 feet prior to penetration	15 liters
Descent from penetration altitude to landing	34 liters
From landing to engine shutdown	13 liters